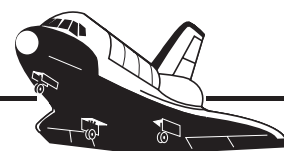


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Mission Highlights STS-89



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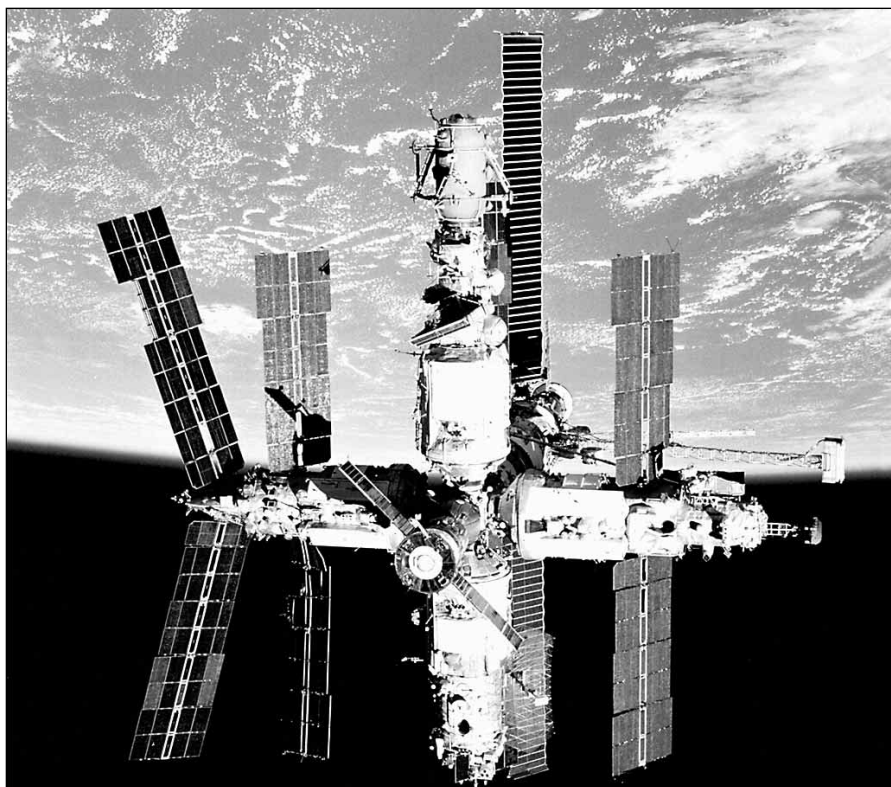
January 1998

Swap of Mir crew marks mission

The *Endeavour* docked with Russia's Space Station, bringing more than 8,000 pounds of supplies and hardware. The STS-89 crew brought home Dave Wolf and left behind Andy Thomas, who began a four-month research mission as the final American to live and work on Mir.

Commander Terry Wilcutt commended Wolf and Thomas. "They're bold, and they're daring adventurers, and I tell you, you may or may not know that it's an all volunteer force and they are out there paving the way for our permanent presence on the International Space Station."

In addition to the transfer activities, the STS-89 mission carried the Spacehab module which contained numerous scientific experiments housed in the *Endeavour*'s payload bay.



This survey view of Mir was provided during a "fly-around" by *Endeavour*.

Mission Events

The Shuttle *Endeavour* rose from launch pad 39A at Kennedy Space Center at 8:48 p.m. CST on January 22, 1998, to kick off the first shuttle mission of 1998. The main focus of the eight-day flight was to transfer crew members to the Russian Space Station Mir.

In addition to the Shuttle-Mir activities, the crew activated the experiments in the Spacehab module, which remained active throughout the flight.

The *Endeavour* successfully docked with Mir at 2:14 p.m. CST on January

Space Shuttle *Endeavour*

January 22-31, 1998

Commander:

Terrence Wilcutt

Pilot:

Joe Edwards

Mission Specialists:

Jim Reilly

Mike Anderson

Bonnie Dunbar

Salizhan Sharipov

Andy Thomas

Dave Wolf



Astronaut David Wolf greets Terrence Wilcutt and Bonnie Dunbar after hatch opening between the docked space craft.

24, and the hatches between the two vehicles were opened at 4:25 p.m. CST to start 5 days of joint activities.

With all of their transfer activities complete, *Endeavour* gently undocked from the Russian Space Station on January 29, at 10:57 a.m. CST and began the journey home.

The crew of STS-89 ended their successful mission with a 4:35 p.m. CST landing at Kennedy Space Center on January 31, 1998.

CARGO BAY PAYLOADS

SHUTTLE-MIR SCIENCE PROGRAM

STS-89 delivered Astronaut Andrew Thomas to Mir as the NASA 7 astronaut and returned Dr. David Wolf to Earth. In addition to the NASA 7 crew member, the shuttle transported approximately 6,000 pounds of research equipment and supplies to the station. This research focused on 27 studies in the areas of advanced technology, Earth sciences, human life sciences, microgravity research, and ISS risk mitigation.

The commercial initiated research from the advanced technology discipline evaluated new technologies and techniques using the Mir space station and the shuttle as a test bed. Such

research in reduced gravity will contribute to an enhanced knowledge base for implementation on the International Space Station and other space vehicles.

Earth sciences research in ocean biochemistry, land surface hydrology and meteorology were performed. Observation and documentation of transient natural and human-induced changes were accomplished with the use of hand-held photography.

Human life sciences research consisted of investigations that focused on the crew members' adaptation to weightlessness in terms of skeletal muscle and bone changes, immune response, psychological interactions and metabolism.

The International Space Station risk mitigation discipline consisted of several technology demonstrations associated with human factors and maintenance of crew health and safety aboard the space station.

IN-CABIN PAYLOADS

The **G-093** payload was designed and built by the students of the University of Michigan, Ann Arbor. Also known as the Vortex Ring Transit Experiment (VORTEX). The scientific objective of the experiment was to conduct observations of the liquid drop

formation process in the case of surface-tension-dominated interface dynamics. The data returned should lead to better methods for atomizing, the effect of a liquid being turned into a mist, fuel. This process is important in the operation of internal combustion engines, as well as producing powders of desired characteristics and manufacturing encapsulated microdroplets for drug delivery.

The **G-141** Structure of Marangoni Convection in Floating Zones payload: Marangoni convection is a gravity independent natural convection phenomenon. In the commercial production technique for high quality silicon crystals, temperature differences are unavoidable. For this reason, Marangoni convection influences the crystallization process and thereby the quality of the crystals obtained. The experiment was designed by The German Aerospace Center, Bonn, Germany, in conjunction with the University Giessen, Germany.

G-145 is entitled Glass Fining and is a collaboration of the German Aerospace Center and the Technical University of Clausthal, Federal Republic of Germany. The scientific objective of the experiment is to gain further insight into the process of glass fining or the removal of all visible gaseous bubbles from a glass melt.

G-432 was built and designed by the Chinese Academy of Sciences, Beijing, China. This payload consists of five separate experiments: Super Cooling, the Processing of High Critical Test, the Growth of Gallium Antimony experiment, the Liquid Phase Epitaxy experiment and the Wettability Test.

CLOSED EQUILIBRATED BIOLOGICAL AQUATIC SYSTEM (CEBAS): CEBAS payload hardware was developed by the German Space Agency (DLR formerly DARA). The minimodule, a habitat for aquatic organisms, enables scientists to conduct various gravity-related experiments in the areas of zoology, botany and developmental biology, as well as in interdisciplinary areas such as scientific research on artificial ecosystems.

MICROGRAVITY PLANT NUTRIENT EXPERIMENT

(MPNE): The main goal of the MPNE was to test a nutrient delivery technology that supports plant growth in space. Plants are grown in MPNE to validate the use of a porous tube delivery system and not specifically for biological research.

EARTHKAM: EarthKAM allowed students to gain a new perspective on planet Earth by operating a digital camera mounted in the overhead window of the space shuttle. The students engage in selecting sites around the world to be photographed during shuttle flights, participate in solving real-world problems that arise, and use tools of modern science, (computers and the Internet) to study the images and the Earth Science processes that they illustrate.

EarthKAM's primary sponsors are the University of California at San Diego; TERC; Johnson Space Center, Houston, TX; Langley Research Center, Hampton, VA; Goddard Space Flight Center, Greenbelt, MD; and the Jet Propulsion Laboratory, Pasadena, CA. Other NASA Center education offices also are supporting the EarthKAM program at various schools in their geographic location.

SPACEHAB PAYLOADS

MECHANICS OF GRANULAR

MATERIALS: This experiment was aimed at understanding the behavior of granular materials, such as sand or salt, under very low confining pressure. Confining pressure is the force that keeps a granular material "sticking together."

The experiment has applications in a wide range of fields, including earthquake engineering; coastal and offshore engineering; mining; transportation of granular materials; soil erosion; the handling of granular materials such as grains and powders; off-road vehicles; geology of the Earth; and planetary geology and exploration. Findings from the experiment may lead to

improved selection and preparation of building sites, better management of undeveloped land, and improved handling of materials in chemical, agricultural and other industries.

The Principal Investigator for the experiment was the University of Colorado at Boulder and the Marshall Space Flight Center.

ASTROCULTURE: STS-89 transported the ASTROCULTURE to Mir to begin an 80-day experiment to determine if wheat plants would produce seed in microgravity. This information became the basis for developing large scale plant-growing units required in a life support system. But, development of the ASTROCULTURE technology has already begun to pay dividends. High intensity light emitting diodes, developed as plant lighting for the facility, may soon be used in cancer treatment, saving lives on Earth. A treatment technique called Photodynamic Therapy uses tiny, densely packed light emitting diodes to activate tumor-treating drugs.

The ASTROCULTURE program is part of a cooperative experiment with the Secondary Payload Program of NASA's Office of Life and Microgravity Sciences and Applications and the Space Product Development Office of the Marshall Space Flight Center in Huntsville, AL.

X-RAY DETECTOR TEST: The X-ray detector is one of the essential elements for the International Space Station's X-ray Crystallography Facility. It detects X-rays reflected from protein crystals and helps to determine their structure, or makeup. It measured the sensitivity of the device to background space radiation and determined any detrimental effect this radiation may have on the instrument. The principal investigator for this experiment is the Center for Macromolecular

Crystallography, University of Alabama at Birmingham.

DIFFUSION-CONTROLLED CRYSTALLIZATION APPARATUS FOR MICROGRAVITY (DCAM):

By pinpointing a protein's structure, researchers can design a drug that will fit into the protein's unique shape to block its undesirable characteristics. DCAM was designed to grow protein crystals at slow, controlled rates in the microgravity environment of space. Researchers are using this apparatus to try to grow larger and purer crystals in the pursuit of therapeutic research to counter the Herpes virus, fundamental virus mapping and to develop new drug delivery systems. The principal investigator for DCAM is new Century Pharmaceuticals in Huntsville, AL.

GASEOUS NITROGEN

DEWAR: Frozen protein samples were transported to the Russian Mir Space Station in a Gaseous Nitrogen Dewar. This investigation was expected to contribute to the understanding of why it is possible for researchers to grow larger and more perfectly formed protein crystals in the microgravity environment of space than on Earth. The principal investigator for this experiment was the University of California-Irvine.

DSO 334: INFLIGHT EVALUATION OF THE TELEMEDICINE INSTRUMENTATION PACK:

Long-duration space shuttle flights and International Space Station missions require the capability for the Flight Surgeons to obtain a more in-depth assessment of crew health so that



Astronaut Michael Anderson works with the Closed Equilibrated Biological Aquatic System.



Astronauts David Wolf and Andrew Thomas check out a Mir tissue experiment.

potentially serious medical problems can be handled appropriately and expeditiously. Currently, the level of in-flight medical care is limited to the medical expertise of the Crew Medical Officer (CMO), who is typically not a physician. Two CMOs, each of whom receives only 16 to 18 hours of medical training, are responsible for providing in-flight medical care and relaying symptomatic information to the Flight Surgeon. The Telemedicine Instrumentation Pack (TMIP) can create a virtual presence by extending the visual and auditory senses of the Flight Surgeon. This will enable the Flight Surgeon to more accurately assess an astronaut's health, and make recommendations regarding in-flight treatment and medically-related mission impacts.

CREW BIOGRAPHIES

Commander: Terrence W. Wilcutt (Lt. Col., USMC). Wilcutt, 48, was born in Russellville, KY, and received a bachelor of arts degree in math from Western Kentucky University.

He became an astronaut in July 1991, was the pilot of STS-68, on which the Space Radar Lab-2 studied

Earth's surface and atmosphere, creating radar images of Earth's surface environment and mapping global production and transport of carbon monoxide pollution.

Wilcutt again served as pilot on STS-79 which rendezvoused with the Russian Mir Space Station and transferred over 3.5 tons of supplies to and from the Mir and exchanged U.S. astronauts on Mir for the first time - leaving John Blaha and bringing Shannon Lucid home after her six month stay aboard. With the completion of STS-89, Wilcutt had logged more than 724 hours of space flight.

Pilot: Joe Frank Edwards, Jr., (Cmdr, USN). Edwards, 39, was born in Richmond, VA, and received a bachelor of science degree in Aerospace Engineering from the United States Naval Academy, and a master of science degree in Aviation Systems from University of TN.

Designated a Naval Aviator in February, 1982. Assigned to Fighter Squadron 143 in 1983 after completion of F-14 Tomcat training. Flew fighter escort and reconnaissance combat missions over Lebanon in 1983 and graduated from U.S. Navy Fighter Weapons School, and the U.S. Naval Test Pilot School. He also served as Operations

and Maintenance Officer in Fighter Squadron 142 and Operations Officer in the Operations Directorate of the Joint Chiefs of Staff, Washington, DC.

Edwards became an astronaut in 1994, and was initially assigned to work technical issues in the Safety Department of the Astronaut Office. He then served as Technical Assistant to the Director, Flight Crew Operations Directorate. With the completion of STS-89, Edwards had logged more than 211 hours of space flight.

Mission Specialist: James F. Reilly, II (Ph.D.). Reilly, 43, was born at Mountain Home Air Force Base, ID, and received a bachelor of science degree in geosciences from University of Texas-Dallas, a master of science degree in geosciences from University of Texas-Dallas, and a doctorate in geosciences from University of Texas-Dallas.

Reilly entered graduate school and was selected to participate as a research scientist specializing in stable isotope geochronology as part of the 1977-1978 scientific expedition to Marie Byrd Land, West Antarctica. He next accepted employment as an exploration geologist with Santa Fe Minerals, Inc., in Dallas, TX. Prior to becoming an astronaut in 1995, Reilly was employed as an oil and gas exploration geologist for Enserch Exploration Inc., in Dallas, TX, rising to the position of Chief Geologist of the Offshore Region.

With the completion of STS-89, he had logged more than 211 hours of space flight.

Mission Specialist: Michael P. Anderson (Maj, USAF). Anderson, 37, was born in Plattsburgh, NY, and received a bachelor of science degree in physics/astronomy from University of Washington, and a master of science degree in physics from Creighton University.

After graduation from the University of Washington, Anderson was commissioned a second lieutenant, and after completing a year of technical training at Keesler AFB, MS, was assigned to Randolph AFB, TX. He

attended Undergraduate Pilot Training at Vance AFB, OK, and was assigned to the 2nd Airborne Command and Control Squadron, Offutt AFB, NE. He served as an aircraft commander and instructor pilot in the 920th Air Refueling Squadron, Wurtsmith AFB, MI, and was assigned as an instructor pilot and tactics officer in the 380 Air Refueling Wing, Plattsburgh AFB, NY.

Anderson became an astronaut in 1995, and was initially assigned technical duties in the Flight Support Branch of the Astronaut Office. With the completion of STS-89, he had logged more than 211 hours of space flight.

Mission Specialist: Bonnie J. Dunbar (Ph.D.). Dunbar, 48, was born in Sunnyside, WA, and received a bachelor of science and master of science degrees in ceramic engineering from the University of Washington, and a doctorate in mechanical/biomedical engineering from the University of Houston.

Dunbar became an astronaut in 1981, and was a veteran of four space flights prior to STS-89. With the completion of STS-89, she had logged more than 1,208 hours in space. Her first flight, STS-61A, was the first to carry eight crew members and the first in which payload activities were controlled from outside the United States. More than 75 scientific experiments were completed in the areas of physiological sciences, materials science, biology, and navigation. During the seven-day mission, Dunbar was responsible for operating Spacelab and its subsystems and performing a variety of experiments.

During the STS-32 mission, crew members aboard *Columbia* successfully deployed the Syncom IV-F5 satellite, and retrieved the 21,400-pound Long Duration Exposure Facility using the RMS. They also operated a variety of middeck experiments. Additionally, numerous medical test objectives, including in-flight lower body negative pressure, in-flight aerobic exercise and muscle performance were conducted to evaluate human adaptation to extended duration missions.

Dunbar flew as Payload Commander on STS-50, the United States Microgravity Lab-1 mission dedicated to microgravity fluid physics and materials science. Over 30 experiments sponsored by over 100 investigators were housed in the "Spacelab" in the shuttle's Payload Bay.

On STS-71 Dunbar served as a mission specialist. This was the first space shuttle mission to dock with the Russian Space Station Mir, and involved an exchange of crews. The Space Shuttle *Atlantis* was modified to carry a docking system compatible with the Russian Mir space station. It also carried a Spacelab module in the payload bay in which the crew performed medical evaluations on the returning Mir crew.

Mission Specialist: Salizhan Shakirovich Sharipov. Sharipov, 33, was born in Uzgen, Oshsk region, and graduated from the Air Force Pilot School and Moscow State University with a degree in cartography. After graduation from the Air Force Pilot School, he worked as a pilot-instructor and taught 8 cadets. He has logged over 950 hours flying time, and he has

experience flying on MIG-21 and L-39 aircraft.

Selected by the Gagarin Cosmonaut Training Center, Sharipov became a cosmonaut-candidate in 1990. In 1992, he completed general space training and became a cosmonaut. As a member of the group he has completed a full course of training for Mir space flights as a crew commander. With the completion of STS-89 he had logged more than 211 hours of space flight.

Mission Specialist: Andrew S. W. Thomas (Ph.D.). Thomas, 46, was born in Adelaide, South Australia, and received a bachelor of engineering degree in mechanical engineering, with First Class Honors, from the University of Adelaide, South Australia, and a doctorate in mechanical engineering from the University of Adelaide, South Australia.

Thomas began his professional career as a research scientist with the Lockheed Aeronautical Systems Company, Marietta, GA. In 1987, Thomas was named manager of Lockheed's Flight Sciences Division and directed the technical efforts in vehicle aerodynamics, flight controls



In-flight portrait: From left, David Wolf, Pavel Vinogradov, Terrence Wilcutt, Anatoly Solovyev, and Bonnie Dunbar. Top, Salizhan Sharipov, James Reilly, and Joe Edwards. At 90-degrees are Andrew Thomas and Michael Anderson.

STS-89

Quick Look

Launch Date: Jan 22, 1998

Time: 8:48 p.m. CST

Site: KSC Pad 39A

Orbiter: *Endeavour*
OV-105—12th flight

Orbit/In.: 160 naut. miles
51.6 degrees

Mission Duration: 8 days, 19 hrs,
47 mns.

Landing Date: Jan. 31, 1998
Time: 4:35 p.m. CST
Site: Kennedy Space
Center

Crew: Terrence Wilcutt (CDR)
Joe Edwards (PLT)
Jim Reilly (MS1)
Mike Anderson (MS2)
Bonnie Dunbar (MS3)
Salizhan Sharipov (MS4)
Andy Thomas (up) (MS5)
Dave Wolf (down) (MS6)

In-Cabin Get Away Specials
Payloads: CEBAS, MPNE,
EarthKAM

Cargo Bay Spacehab,
Payloads: Orbiter Docking System

and propulsion systems that supported the company's fleet of production aircraft. In 1989, he moved to Pasadena, CA, to join the Jet Propulsion Laboratory and, shortly after, was appointed leader of the JPL program for microgravity materials processing in space.

Thomas became an astronaut in 1993, and was subsequently named as payload commander for STS-77. During this 10-day mission the crew

deployed two satellites, tested a large inflatable space structure on orbit and conducted a variety of scientific experiments in a Spacehab laboratory module carried in *Endeavour's* payload bay.

With the completion of STS-89, Thomas had logged more than 451 hours of space flight. He is scheduled to spend four months aboard the Russian Space Station Mir.

Mission Specialist: David A. Wolf (M.D.). Wolf, 41, was born in Indianapolis, IN, and received a bachelor of science degree in electrical engineering from Purdue University, and a doctorate of medicine from Indiana University. He completed his medical internship at Methodist Hospital in Indianapolis, IN, and USAF flight surgeon primary training at Brooks Air Force Base in San Antonio, TX.

Wolf joined the Medical Sciences Division at Johnson Space Center and was responsible for development of the American Flight Echocardiograph for investigating cardiovascular physiology in microgravity. In 1986 he was assigned to direct development of the Space Bioreactor and associated tissue engineering and cancer research applications utilizing controlled gravitational conditions. This resulted in the state of the art NASA rotating tissue culture systems.

Wolf became an astronaut in 1991 and participated as a mission specialist on STS-58 which was a 14-day dedicated Spacelab life sciences research mission. During this shuttle mission the crew conducted neurovestibular, cardiovascular, cardiopulmonary, metabolic, and musculoskeletal research utilizing microgravity to reveal fundamental physiology normally masked by Earth gravity. With the completion of STS-89, Wolf had logged more than 3,408 hours of space flight.

This and other fact sheets may be accessed via the world wide web at:

<http://www.jsc.nasa.gov/pao/factsheets>



The link between the United States and Russia is symbolically represented by the Space Shuttle *Endeavour* and Space Station Mir orbiting above the Bering Strait between Siberia and Alaska. The success of the joint U.S.-Russian missions is depicted by the Shuttle and Mir colored by the rising sun in the background. A shadowed representation of the International Space Station rising with the sun represents the future program for which the Shuttle-Mir missions are prototypes. The inside rim of the patch describes the outline of the number eight representing STS-89 as the eighth Shuttle-Mir docking mission. The nine stars represent the nine joint missions to be flown on the program and when combined with the number eight in the rim reflect the mission number. The nine stars also symbolize the children of the crew members who will be the future beneficiaries of the joint development work of the space programs of the two countries. Along the rim are the crew members' names. The red, white, and blue of the rim reflect the colors of the American and Russian flags which are also represented in the rim on either side of the joined spacecraft.